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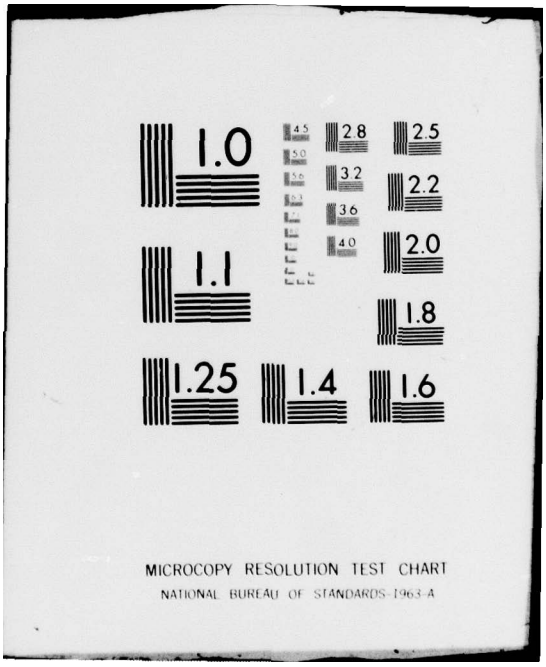
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NRL Memorandum Report 4055

Using Intelligent Graphics Terminals in Real-Time Processing

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August 24, 1979

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Washington, D.C.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

At the Naval Research Laboratory intelligent graphic terminals are being utilized for real-time acquisition, storage, processing and display of oceanographic data when mini-computer systems are inappropriate. The intelligent graphic terminal is a well packaged, low cost, reliable and highly portable micro-computer system capable of performing many of the functions required of mini-computer systems. Discussed in the paper are methods of configuring, implementing and utilizing the intelligent graphics terminal for real-time oceanographic processing.

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USING INTELLIGENT GRAPHICS TERMINALS IN REAL-TIME PROCESSING

I. Introduction

Mini-computer systems have to a large extent successfully fulfilled the oceanographic researchers requirements for data collection, processing and storage in the field and in the laboratory. At NRL mini-computer systems are placed aboard ships, aircraft and land based sites on a routine basis. It is expected that the mini-computer will continue to meet the needs of the researcher for a long time, since the hardware and software are being enhanced by the various manufacturers at a very rapid pace and more applications are continually being computerized.

At NRL there are frequently field experiments conducted where the mini-computer is inappropriate. These experiments are usually aboard aircraft where there is insufficient space, adequate power is not available, the experiment is "piggy backing" another experiment or the manpower to ship, install and operate the mini-computer system cannot be justified. NRL has found a suitable alternative and has developed real-time oceanographic data acquisition and processing systems using intelligent graphics terminals when mini-computers are inappropriate.

NRL considered the use of programmable calculators, commercially available microcomputers and a memory based mini-computer system before selecting the intelligent graphics terminal as the data acquisition and processing device. The terminal was selected because of its ability to be programmed in assembly language and BASIC, its highly portable nature, the built in cassette drives to store the programs and data, its programmable graphics capability, its low cost and when it's not replacing a mini-computer it makes a very desirable computer graphics terminal.

II. Description of Intelligent Graphics Terminal

A brief definition of an intelligent graphics terminal for the purpose of this paper is, a terminal with a CRT display and keyboard that can be programmed to perform tasks outside its normal terminal function as well as provide graphical plotting functions.

The Hewlett Packard HP2647A intelligent graphics terminal was selected as the best terminal to replace the mini-computer system. The terminal is modularized and can be configured for data acquisition under

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assembly language programs where maximum speed and flexibility in programming and I/O (Input/Output) can be achieved or it can be configured to be programmed under BASIC using a compatible IEEE 488 standard interface for I/O.

Figure 1 are photographs of the HP264X terminal. The electronic circuit boards shown in the terminal can be easily removed and the terminal reconfigured for any application. The following features listed below make the terminal an excellent device for data acquisition, storage and display.

- 128K bytes of graphic, alphanumeric and programmable memory
- refresh type display
- dual unformatted cassette tape drives
- interface for 5 parallel 16 bit data words at TTL levels
- keyboard with function keys that permit paging under alphanumerics and cursor positioning with ZOOM IN and ZOOM OUT features
- weight of 43 pounds
- power required of 4 amps
- size of approximately 2.5 cubic feet
- can be programmed in an Intel 8080 compatible assembly language or BASIC
- internal clock that can be used when scheduling programs
- ability to utilize operating system software when programming
- supported software with terminal debugger/assembler and cross assembler for HP1000 mini-computers
- writes compatible HP1000 mini-computer cassette tapes
- worldwide service and parts
- can attach peripherals directly to terminal on video interface or IEEE 488 compatible interface

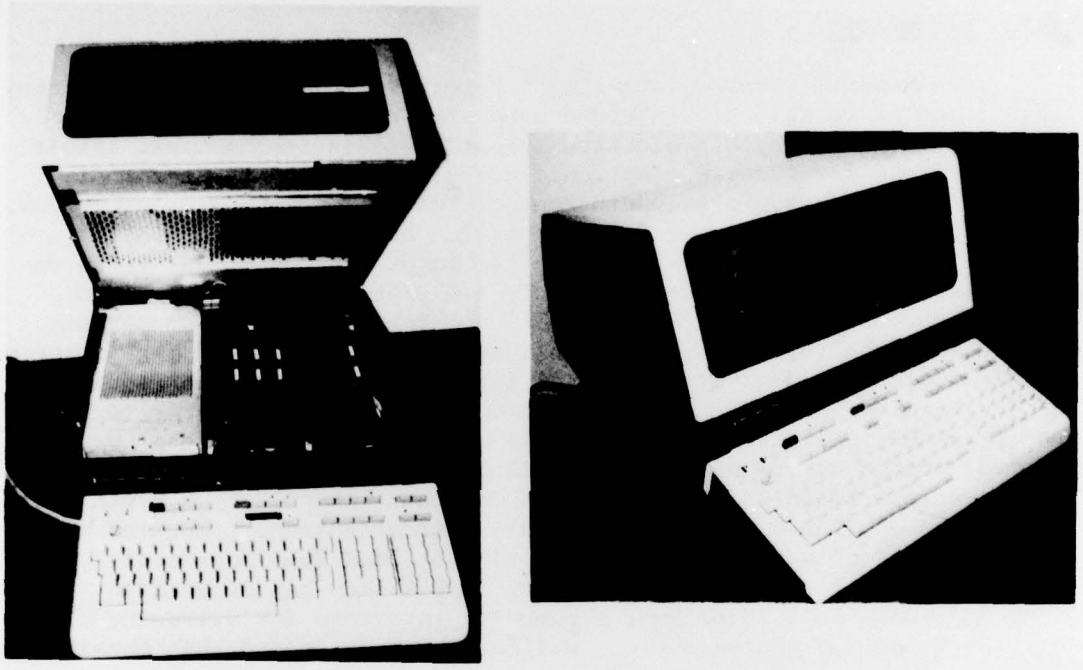

Fig. 1 — Photographs of HP264X terminal

The less desirable features of the terminal are listed below.

- relatively small display for graphical output
- maximum 110K bytes of storage on a cassette
- operates at microcomputer speeds which are significantly slower than mini-computers

III. Discussion

The Hewlett Packard intelligent terminal can be configured in many ways in order to suit the intended use. Reconfiguring a terminal is done by utilizing certain electronic boards within the terminal itself. There is room for fifteen electronic circuit boards in the terminal. Eight of the boards are standard control boards for keyboard, processor, memory control and cassette drive control. An additional board is required for display memory. Memory can range from 4K to 32K bytes on a single board. This leaves six empty I/O slots in the terminal to be configured based upon the application. Table 1 shows a comparison of the ways the terminal can be configured. For a standard alphanumeric terminal to a computer system an I/O interface card would be required in the terminal and the unit is referred to as an HP2645. For terminal and graphics applications on line to a computer, two additional graphic control boards are required, an additional memory control board and an I/O interface board to the computer. This unit is sold by Hewlett Packard as an HP2648 Graphics Terminal. For standalone computing the terminal is configured with graphics control, and four boards of ROM and RAM memory. This leaves two empty boards that can be used for an IEEE 488 compatible interface, a computer interface for switching from offline to online operations and a video interface board that permits direct copying to hard copy video devices such as the Tektronix 4632. The IEEE 488 interface can be connected to external devices with compatible outputs. Commercially available devices with compatible outputs are printers, plotters, DVM's and other test equipment. This intelligent graphics terminal is called an HP2647. Its primary use is for offline programming in BASIC and it supports an easy to use graphics software package that operates under BASIC. For assembly language terminal applications the HP2649 is offered. This terminal is usually configured with the standard eight control boards and two 32K byte RAM memory boards. A Debugger/Assembler and cross compiler that operates on the HP1000 is available for writing, compiling and debugging programs. With this configuration up to five additional boards may be added to the terminal.

Table 2 shows a comparison between the HP2647 and the HP2649 terminal capabilities. The major tradeoffs between the terminals in a standalone data acquisition and processing mode is the HP2647 is good for ease of programming, data computation, processing, plotting and for I/O using an IEEE 488 device; whereas the HP2649 is significantly faster for

TABLE 1

Comparison of HP264X Intelligent Terminal Configurations

	HP2645	HP2647	HP2648	HP2649
Standalone Data Acquisition	NO	YES	NO	YES
Graphics Hardware	NO	YES	YES	NO
Interface Normally Used	RS232	IEEE 488	RS232	8 Bit Duplex
Programming Language	NONE	BASIC	NONE	ASSEMBLY
Available I/O Slots	6	2	3	5
Major Use	Alphanumeric Computer Terminal	Standalone Computing and Graphics Terminal	Alphanumeric and Graphic Computer Terminal	Standalone Data Acquisition Processing Storage

TABLE 2

Comparison of HP2647 and HP2649 Capabilities

	HP2647	HP2649
Standalone Data Acquisition	Fair	Good
Ease of Programming	Good	Fair
Software Flexibility	Fair	Good
Graphics Hardware	Yes	No
Computational Capability	Good	Fair
Speed	Slow	Fast

real-time data acquisition without the overhead of the BASIC interpreter, more flexible since bits can be easily manipulated and the I/O can support up to five sixteen bit parallel words.

IV. Description of AXBT Intelligent Terminal System

Acoustic studies are being performed by NRL and NAVOCEANO this year in areas where oceanographic eddy currents exist. NRL aircraft are being used to locate these eddies by dropping AXBT's in a pattern to define the temperature boundaries. These aircraft flights last for one or two days, occur approximately every two weeks and take place aboard different NRL aircraft.

For real-time data acquisition, processing and storage the intelligent graphics terminal was selected. The terminal was selected because of its highly portable nature, it can be installed and removed in minutes without the need of special equipment, it can be transported easily with personnel, small and compact in size and can be operated by the scientist with a small amount of training.

Two intelligent terminals were used for the experiments. One of the terminals was configured as a HP2649 for real-time data acquisition, processing and storage while the other terminal was configured as a HP2647 for computation and plotting. The HP2649 terminal was configured with three 8 bit duplex register boards. A functional diagram of the terminal's real time AXBT data acquisition system is presented in Figure 2. The output from the AXBT receiver was interfaced to one of the 8 bit duplex interface boards, since the receiver provided an 8 bit binary value at TTL levels. A clock was interfaced to a second 8 bit duplex board and time in seconds recorded when the receiver interrupted with data. A binary panel was used to start, stop and identify the XBT. The panel was interfaced to the third 8 bit duplex board. Data acquired by the terminal was placed on the terminal display and recorded permanently on a cassette cartridge. This real-time acquisition processing and display provided the scientist with immediate information where the eddy was located and information to be used in the near future and immediately by ships conducting experiments in the area.

The second terminal configured as an HP2647 Intelligent Graphics Terminal was utilized to perform computations on the data, format the data, display and print out the data and plot the results. The processed data and plotted results were obtained in hard copy format by interfacing an HP2631G Printer/Plotter to the terminal using an IEEE 488 compatible interface. Figure 3 is a copy of an AXBT plot produced aboard the aircraft. The terminal was programmed in BASIC and data was transferred between terminals using the cassette cartridges. A result of the additional processing on the HP2647 is a listing and plot of XBT temperatures as a function of depth at one second intervals converted from degrees Fahrenheit to degrees centigrade. Following the experiment

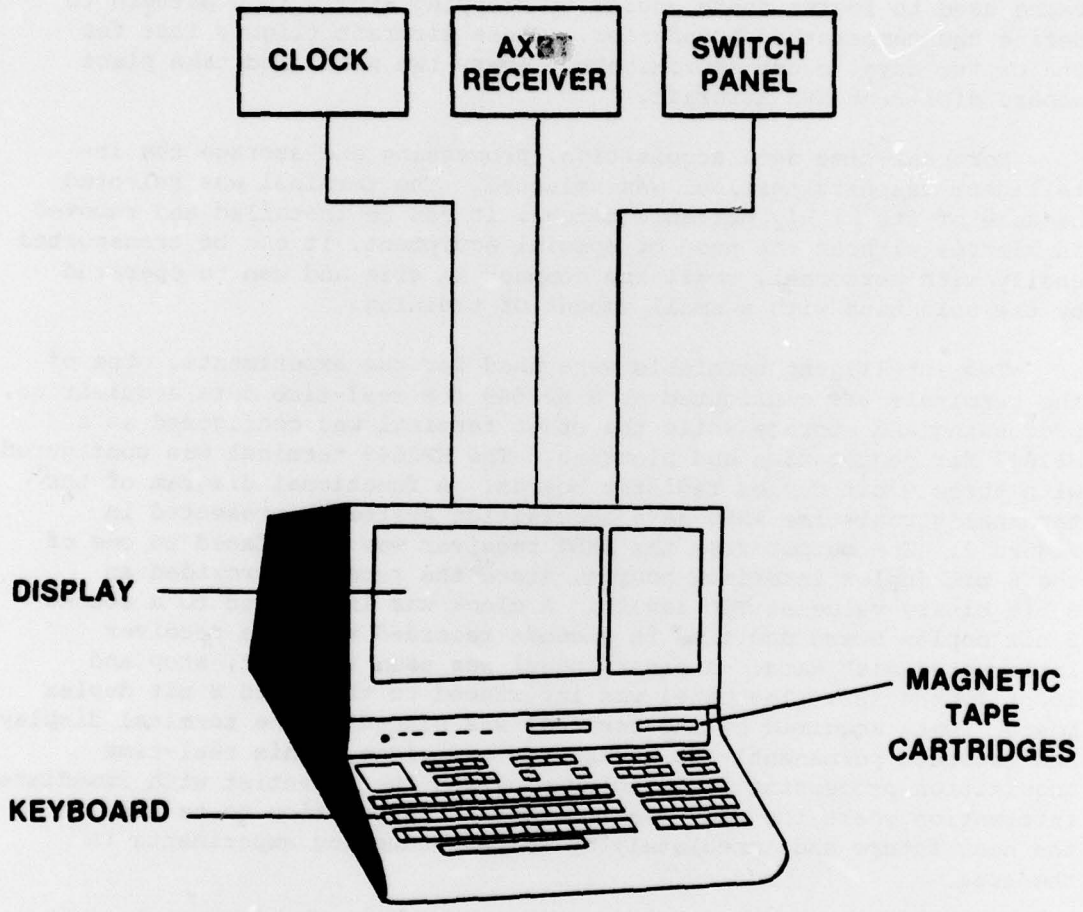

Fig. 2 - Functional block diagram of terminal AXBT system

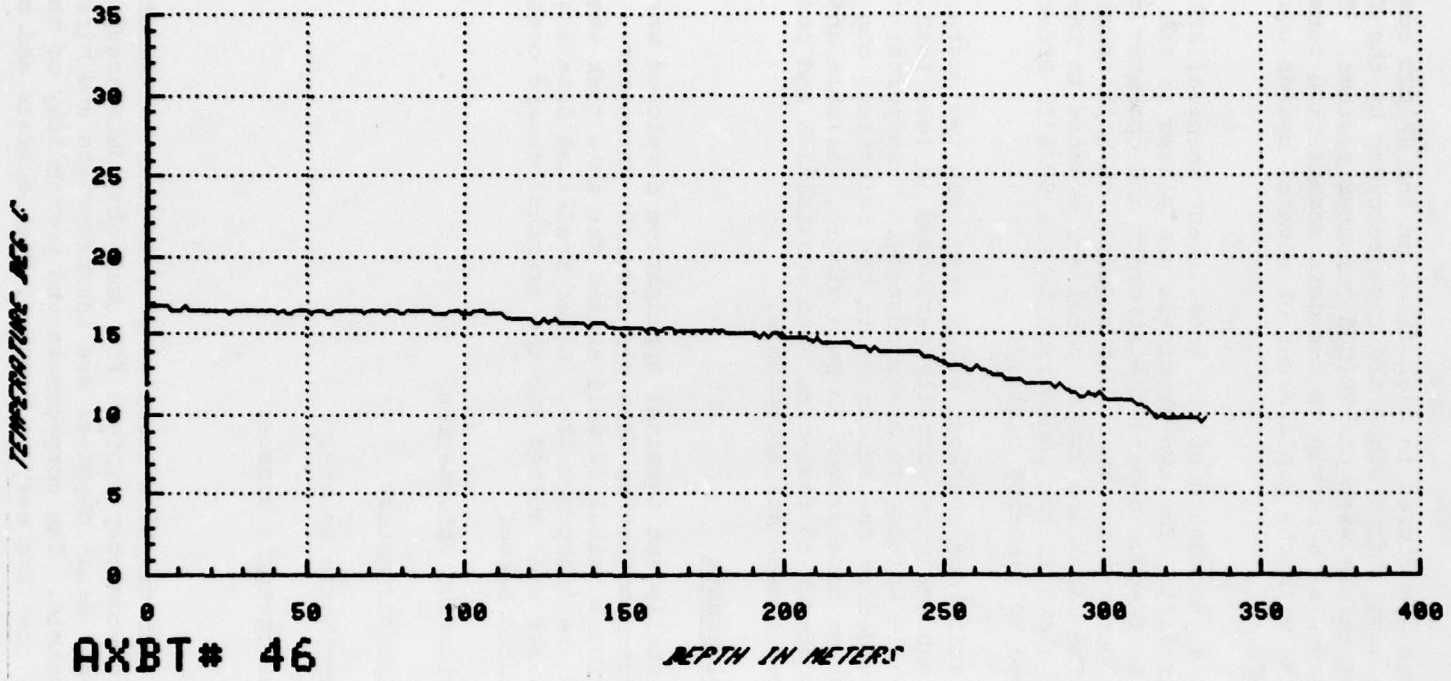

Fig. 3 - AXBT plot produced aboard NRL aircraft

the cassette tapes are stored in disk files on the HP1000 computer system. This is easily done since the tape recorded by the HP264X terminals are compatible with the HP1000 computer systems. The HP2647 terminal also serves as a backup to the data acquisition terminal. In just a few minutes with the replacement of several boards the HP2647 becomes an HP2649.

Figure 4 is a photograph of the intelligent terminal AXBT system aboard an NRL aircraft. The two terminals are placed in the same location for lack of space aboard the aircraft and operator convenience. One operator can perform the functions required on both terminals at the same time. The clock and switch panel are mounted in the same short rack. Not shown in the photograph is the HP2631G Printer/Plotter which was strapped to a nearby table.

The installation and checkout takes less than two hours. Dismantling of the equipment is normally performed in less than one-half hour and often while waiting to clear customs. Transportation of the equipment is provided by the scientist in the scientists own vehicle. The terminal systems have proven to be a viable, reliable and a very cost effective approach to real-time data acquisition and processing when microcomputer speeds are acceptable.

V. Future Developments

The first intelligent terminal application developed was for the purpose of recording magnetics data and aircraft parameters. Tests have shown that the terminal is well suited for this task when mini-computer systems are inappropriate. Other real-time data acquisition and processing tasks well suited for the terminal aboard oceanographic platforms are listed below.

- Navigation information
- Ships parameters
- Atmospheric sensors
- Oceanographic sensors

VI. Summary

The intelligent graphics terminal is a low cost alternative to oceanographic mini-computer systems for real-time data acquisition and processing when mini-computers are inappropriate and microcomputer speeds are acceptable. The compactness and portability of the units are unsurpassed, they are easy to program, use, operate and maintain

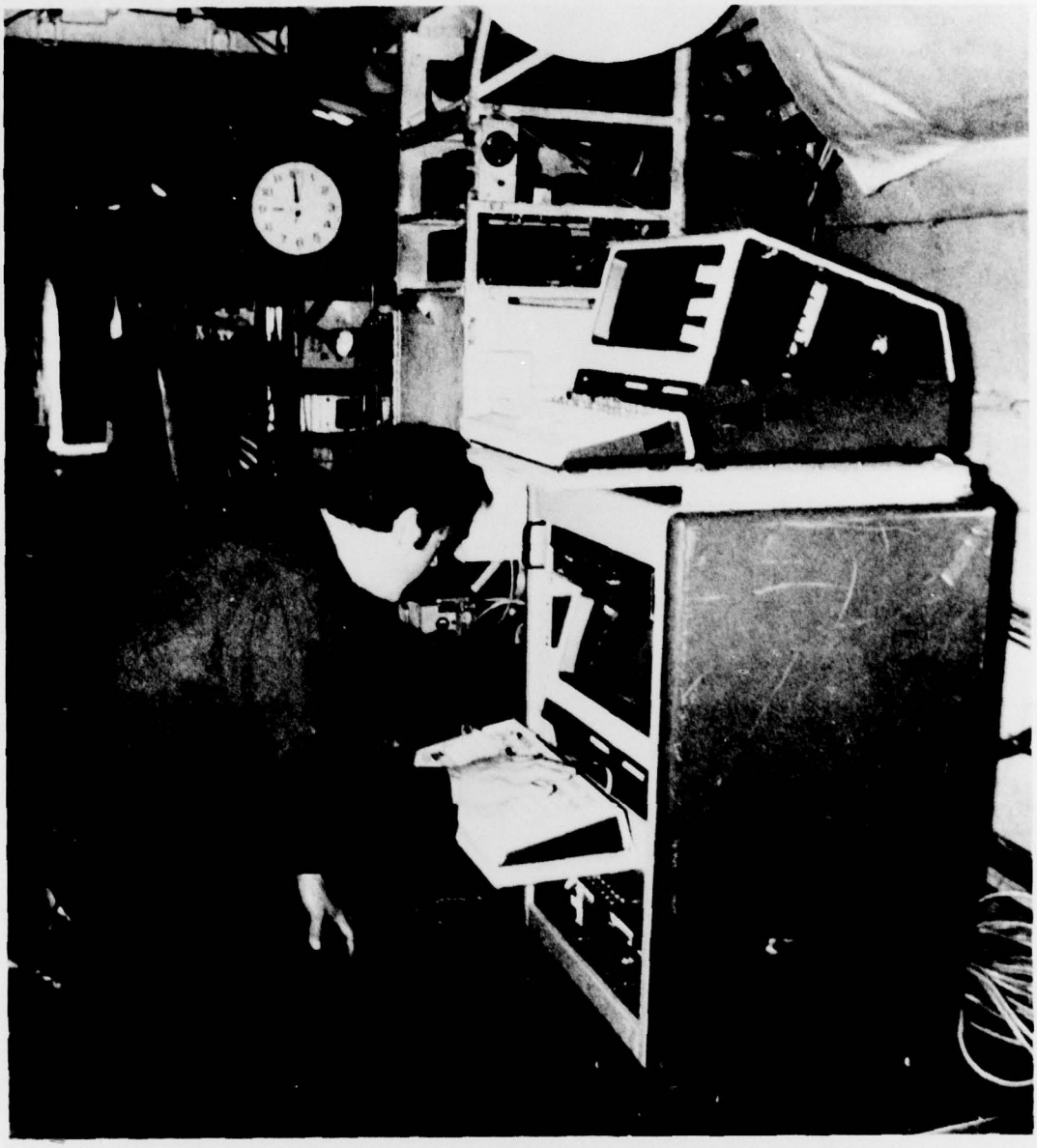

Fig. 4 — Photograph of intelligent terminal AXBT system aboard NRL aircraft

and the cost is much lower than the mini-computer system. The data that is recorded on HP264X cassette drives are fully compatible with the Hewlett Packard HP1000 mini-computer systems making data transfers exceptionally easy and fast between terminal and computer. When the terminal is not functioning as a microcomputer system it makes an excellent alphanumeric and graphics terminal to the computer system.

Finally, the intelligent graphics terminal can be thought of as a well packaged, reliable and state of the art microcomputer system.